Appropriate Technology

Priorities for hospital cleaning, disinfection, sterilisation, and control of infection

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The continuing high prevalence of infectious diseases in developing countries—in contrast to the dramatic decline of such diseases in the West—has been attributed to many factors, among which poor sanitation and hygiene, inadequate medical services, and malnutrition are foremost. In this article I consider what measures may be taken in a district hospital in the Third World, to help in controlling infection and achieving a reasonable standard of hygiene. In developing countries policies for the treatment and control of infectious disease need to be geared to the specific needs of the community and take into account the fact that many hospitals have no electricity, an inadequate water supply, and no reliable sewage facilities. Such circumstances necessitate a simplified and more fundamental approach that is both economically viable and effective. Although direct comparison with standards feasible in the West may not always be appropriate, it may be beneficial in stimulating a re-examination of conventional and possibly wasteful practices.

Limited resources and adverse geographical factors are important considerations in formulating public health policies, but effective health measures also call for understanding the local cultural practices and religious beliefs. Various approaches have been made—for example, that put forward by the Environmental Health Division of the Royal Army Medical Training Group, Keogh Barracks, Ash Vale, nr Aldershot, Hants. Other organisations that provide advice and training schemes on various aspects of public health are listed at the end of this article.

Water supply

A safe, clean water supply is essential. A piped supply is preferable, but water from a deep well or standing tank collecting rainwater is adequate. The first step is purification, which entails removing suspended organic matter by filtering the water through mechanical pressure filters—for example, the Voges filter—or by slow sedimentation. For some purposes this may be all that is required, but water for drinking requires further measures to destroy contaminating micro-organisms. This may be done by fixed dose chlorination (minimum residual chlorine level 2 ppm), preferably using a chlorinator (sodium thiosulphate may then be added to improve the taste), or by adding water purification tablets.

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Sterile bottled water may be prepared in the hospital provided that high standards are maintained in distillation and sterilisation. An autoclave specifically designed to take bottled fluids is necessary, and this must be in good working order. Alternatively, sterile bottled water may be bought, but it is likely to be expensive. Irrespective of the source, care must be taken in the storage of all sterile fluids and the containers must be critically examined regularly; if there is any evidence of defective sealing or contamination of the fluids they must not be used. Once the container has been opened the contents should be used straight away or rejected. Boiled water is not sterile and should not be used to make up solutions for intravenous use. Boiling does, however, reduce the bacterial and viral load to a safe level for drinking and for making up oral rehydration fluid and powdered infant feed.

Waste disposal and sewage

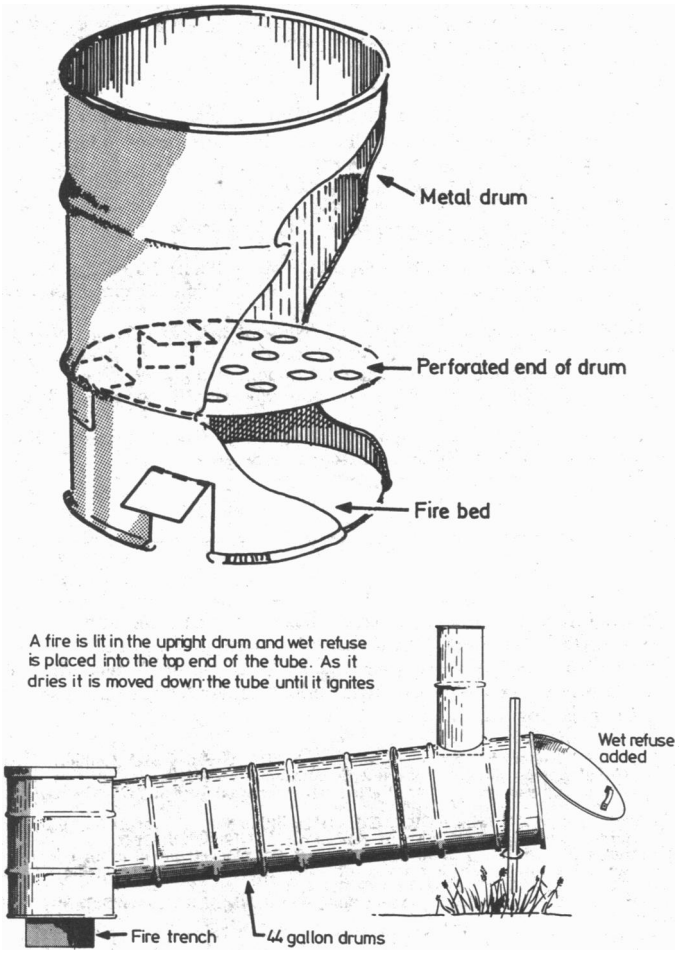
Effective disposal of human excreta and hospital refuse is vital to combat the spread of disease carried by flies and rats. The best way to dispose of hospital waste is to burn it in an incinerator in the hospital grounds or a safe site elsewhere. Incinerators may be made from empty metal drums or sheets of corrugated iron (figure). Waste for incineration should be taken to a designated area and stored in lidded bins until burnt. A piped sewage system to either a mains sewer or a septic tank is the best way to dispose of human excreta, but such a system is practicable only if the water supply is ample and uninterrupted. An alternative method is to dig deep trench latrines (which should be covered to exclude flies) and improvised urinals with soakage pits. Both hospital staff and patients need to be taught that many diseases, especially gastrointestinal disorders, may be spread by the faecal/oral route, and advice on basic hygiene must be an integral part of any community health education programme. In the hospital ward urinals and bedpans should be removed from the patient immediately after use and the contents disposed of in a designated area. Pans should then be thoroughly cleaned and disinfected in a separate area well away from food—preferably with hot water (80°C) or, alternatively, by immersion in a disinfectant. Laboratory waste such as discarded cultures and specimens should be rendered safe to handle by autoclaving before transporting in sealed containers to a designated site for incineration.

Sterilisation of instruments and dressings

Sterilisation by heat is the method of choice in the hospital. Unwrapped metal or glass instruments may be processed either by moist heat in a simple downward displacement autoclave

or by dry heat in a hot air oven. Porous loads such as dressings must only be processed in the more complex high vacuum cycle autoclaves. Selection of the most up to date machines is not always wise (and may be expensive), for they may break down if the steam supply is poor or intermittent and are difficult to repair. Provided that the standard conditions of temperatures and time recommended by the Medical Research Council are met and the recommended procedures carried out,[1 2] a simple machine design is quite adequate. One such example is the multipurpose compact autoclave (manufactured by Thackray), which is suitable for sterilising wrapped and unwrapped instruments, dressings and other porous articles, and bottled fluids. The machine is manually operated and runs off either a direct steam supply or clean cold water that is heated up by electricity.

Autoclaves that operate on a fully automatic cycle reduce operator errors but need trained staff to check that the machine



Simple incinerators. (Drawing based on illustrations in *Sketches of Field Hygiene Appliances*, 1st Preventive Medicine Company, Ingleb.)

achieves the necessary cycle characteristics. Simple autoclaves built on similar lines to a pressure cooker and heated by wood or electricity may be used to sterilise unwrapped instruments and utensils and are more effective than simply putting them in boiling water. Unwrapped instruments should be used immediately after sterilisation. If allowed to dry and then stored in clean conditions the instruments may get recontaminated and will need to be sterilised again before use. Wrapped sterile instruments, disposable syringes, needles, and fine catheters should be stored carefully in lidded boxes in a dry site away from direct sunlight, direct heat, and vermin. The expense and restricted availability of prepacked items will preclude their use in many hospitals, so it is advisable to buy items that are made of material that may be recycled.

Cleaning the hospital

Cleaning walls and other flat surfaces is easier if the surfaces are reasonably smooth, so the junction between walls and floors should be covered and crevices sealed. Dusting or sweeping floors with brushes impregnated with water or oil helps discourage dust from rising up. Floors should be kept socially clean by the most appropriate method for the type of surface. For washing floors and other surfaces a detergent and soap solution is sufficient. Cotton floor mops should be washed after use and dried thoroughly in direct sunlight with the head uppermost before being put away. Walls, floors, and furniture need to be disinfected only if contaminated with potentially infected material, for example, faeces, urine, or blood. Lavatories should be thoroughly cleaned and disinfected twice a day, or more frequently as necessary.

Throughout the hospital care needs to be taken to ensure that the ventilation is adequate. Movement of insects through open windows may be reduced by putting up mesh screening.

Care in the kitchen

Kitchen staff need to be trained to maintain high standards of hygiene to prevent outbreaks of food poisoning and the transmission of other gastrointestinal infections. Handwashing before and after preparing food is essential, and plenty of readily accessible hand wash basins need to be provided. Cooked and uncooked food should be handled separately and stored in separate, covered containers. Refrigeration facilities are important and must be well maintained. All work surfaces should be easy to clean.

Staff should be aware of the length of cooking time required to destroy microbes in meat and poultry, and the possibility of there being carriers of enteric pathogens not only among catering staff but also throughout the hospital. Food prepared for individual patients by their relatives is another possible source of contaminated food entering the hospital.

Laundry

Separate laundry facilities with reliable machines to do really hot washes are the optimum. Simple jacketed machines using steam heated by a wood fire may be just as effective as Western style machines. If no machines are available washing by hand using hot water followed by drying in direct sunshine is adequate because ultraviolet rays have an appreciable disinfectant action. Soaking laundry in large containers of disinfectant is not a good way to clean it. Soiled articles should be placed in sealed bags or covered containers in a designated area and washed properly as soon as possible.

Disinfection

Every hospital needs a disinfectant policy, and staff should be taught how to use disinfectants at the recommended concentration following the manufacturer's instructions. I suggest that the following types of disinfectant should be stocked:

(1) General purpose clear soluble phenols such as Lysol or Clearsol to be used in conditions where organic soiling is high—for example, faecally contaminated sites.

(2) Hypochlorites such as Chloros and Domestos are rapidly acting inexpensive disinfectants that are suitable for the disinfection of surfaces contaminated by blood and for wiping down surfaces on which food is prepared.

(3) Two per cent buffered glutaraldehydes are expensive but a good way to decontaminate heat labile equipment such as transducers or fibreoptic endoscopes. (Their relative toxicity and expense preclude their use as general purpose disinfectants.)

(4) Skin disinfectants, such as Hibitane and Betadine, may be

used as detergent based emulsions with water or as alcohol preparations.

Hospital staff need to get into the habit of regular handwashing, but this is possible only if there are enough wash basins throughout the hospital, and ideally these should have a continuous supply of soap and clean disposable towels. Alcoholic disinfectant preparations, such as Hibisol, are more effective than their aqueous counterparts and may be used as well as basic soap and water for procedures that require a high standard of cleanliness. Many procedures are best carried out with sterile gloves, but if supplies are restricted great emphasis must be placed on scrupulous hand disinfection.

Additional measures

Control of antibiotic prescription by an agreed hospital policy is an important part of any policy to control hospital infection. Indiscriminate use of antibiotics increases the incidence of infection with resistant bacteria. If possible, arrangements should be made to isolate patients with serious and contagious infections and to carry out barrier nursing if necessary. Reasonable standards of health care can be maintained only through the cooperation of all the hospital staff. Greater awareness of the essential facts about the spread of disease and how to carry out the measures described above should ensure that a reasonable standard of hygiene is maintained in the hospital.

I am grateful to the following colleagues in the preparation of this article: Professor W A Gillespie, department of microbiology, Bristol Royal Infirmary; Major B Hart, Environmental Health Division, RAMC Training Group; Mr W J Jones, consultant engineer for Crown Agents for Overseas Governments and Administrations; Miss Annette Viant, nursing officer infection control, Bristol Royal Infirmary; and Miss Elizabeth Jenner, nursing officer, Whittington Hospital.

References

[1] Working party on Pressure-steam Sterilisers. *Sterilisation by steam under increased pressure.* London: Medical Research Council, 1959.
[2] Medical Research Council. Memorandum. London: MRC, 1962. (MRC Memorandum No 41.)

Organisations that give advice on public health measures

(1) Environmental Health Division, Royal Army Medical Training Group, Keogh Barracks, Ash Vale, Nr Aldershot, Hants.
(2) Hospital Estate Management and Engineering Centre, Eastwood Park, Falfield, Gloucestershire GL12 8DA. (Provides regular training courses abroad for engineers and other hospital staff.)
(3) Infection Control Nurses Association, secretary Miss G Weymont, senior nurse, infection control, Royal United Hospital, Bath. (Provides advice, training schemes, and teaching aids for nurses in infection control.)
(4) Central Sterilising Club, honorary secretary Dr R A Simpson, Department of Microbiology, Bristol Royal Infirmary, Bristol BS2 8HW. (A multiprofessional society offering advice on all aspects of disinfection, sterilisation, and infection control in the hospital.)
(5) Division of Hospital Infection, director Professor E M Cooke, Central Public Health Laboratory, Colindale Avenue, London NW9 5HT.
(6) Hospital Infection Research Laboratory, director Professor G A J Ayliffe, Dudley Road, Birmingham B18 7QH.

Recommended reading

Aspects of Infection Control, a series of free booklets available from Pharmaceutical Division, Imperial Chemical Industries plc, Alderley Park, Cheshire. Useful titles in the series are:
Ojajarui J. *Hands as vectors of disease.*
Nyström MD. *The disinfection of objects and inanimate surfaces in hospitals.*
Alder VG. *Central sterile supply and medical equipment decontamination centres.*

Lowbury EJL, Ayliffe GAJ, Geddes AM, Williams JD, eds. *Control of hospital infection. A practical handbook.* 2nd ed. London: Chapman and Hall, 1981.
Ayliffe GAJ, Collins BJ, Taylor LJ. *Hospital acquired infection, principles and prevention.* Bristol: John Wright, 1982.
Maur IM. *Hospital hygiene.* 2nd ed. London: Arnold, 1978.
Bennett JV, Brachman PS, eds. *Hospital infections.* Boston: Little Brown, 1979.
Ayliffe GAJ, ed. *The Journal of Hospital Infection.* Academic Press in association with the Hospital Infection Society.

Is it possible to use natural oestrogens and progesterone (or retroprogesterone) for the combined oral contraceptive pill—the oestrogen for its antiovulatory effect and the progesterone for cycle regulation? Recent articles suggest that some can be absorbed by the oral route. Would such combinations be too expensive, and would they disturb biochemical values less?

The ovary produces many sex steroids, but the main oestrogen is 17β-oestradiol. Crystalline 17β-oestradiol is poorly absorbed from the gastrointestinal tract (or rapidly inactivated by the liver), but micronised 17β-oestradiol is active when taken by mouth.[1] Oral administration, however, is followed by a rise in plasma oestrone concentration that is greater and more rapid than the rise in plasma oestradiol, and shows that the oestradiol is rapidly metabolised to oestrone—probably by the small bowel wall.[1] Oestradiol is currently marketed for menopausal symptoms as oestradiol valerate tablets, which cost about two to three times as much as the oral contraceptive pill and contain about 30 times more oestrogen by weight than the contraceptive pill (which has a more potent artificial oestrogen). Progesterone is said to be rapidly absorbed from the gastrointestinal tract but completely inactivated by the liver. Oral progesterone, however, may produce blood concentrations that briefly reach the range found in the luteal phase of the cycle, though these concentrations are not sustained.[2] It is said that 300 mg daily of progesterone will inhibit ovulation; this dose is 100-2000 times greater by weight than the dose of artificial progestogen in the pill. Progesterone is available for conditions such as premenstrual syndrome as 200 or 400 mg suppositories, costing about 10 times as much as oral contraceptives. The economics of manufacturing oestradiol and progesterone might differ if large scale production were required for oral contraceptives. In view of the problems with metabolism it is difficult to say whether large doses of natural hormones would disturb biochemical values more or less than low doses of artificial steroids. Vaginal rings for administration of natural hormones are being studied.[3] Two theoretical points may also be relevant. One is that during the natural cycle oestrogen appears first alone and then in combination with progesterone, and this may have effects different from simultaneous administration of both hormones. The other point is that for some organs (such as the breast) the effects of the "natural" cycle may not be entirely benign.[4]—JAMES OWEN DRIFE, senior lecturer in obstetrics and gynaecology, Leicester.

[1] Yen SSC, Martin PL, Burnier AM, Czekala NM, Greaney MO, Callantine MR. Circulating estradiol, estrone and gonadotropin levels following the administration of orally active 17β-estradiol in postmenopausal women. *J Clin Endocr Metab* 1975;**40**:518-21.
[2] Whitehead MI, Townsend PT, Gill DK, Collins WP, Campbell S. Absorption and metabolism of oral progesterone. *Br Med J* 1980;**280**:825-7.
[3] Stumpf PG, Maruca J, Santen RJ, Demers LM. Development of a vaginal ring for achieving physiologic levels of 17β-estradiol in hypoestrogenic women. *J Clin Endocr Metab* 1982;**54**:208-10.
[4] Drife JO. Breast cancer, pregnancy, and the pill. *Br Med J* 1981;**283**:778-9.

Some years ago a doctor told me that quinidine sulphate was better than quinine for muscular and night cramps. Since then I have used both, with almost equal results. Recently a local chemist has queried the use of quinidine on the grounds that it is a heart drug. Is quinidine safe, and possibly better for these cramps, as stated, or is it possibly more dangerous and should I stick to quinine?

Quinidine is the dextrostereoisomer of quinine. It has the same pharmacological actions as quinine but with a greater effect on the heart.[1] Both drugs increase the refractory period of skeletal muscle and have a curare-like effect on the motor endplate.[2] I would expect quinidine to be as effective as quinine in preventing cramp but have been unable to find any evidence that it is better. In view of its potential cardiotoxicity it seems inadvisable to substitute it for quinine in the treatment of cramp.—LINDA BEELEY, consultant clinical pharmacologist, Birmingham.

[1] Gilman AG, Goodman LS, Gilman A, eds. *Goodman and Gilman's the pharmacological basis of therapeutics.* 6th ed. London: MacMillan, 1980:768.
[2] Gilman AG, Goodman LS, Gilman A, eds. *Goodman and Gilman's the pharmacological basis of therapeutics.* 6th ed. London: MacMillan, 1980:1055-6.